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LEWIS MATERIALS RESEARCH AND TECHNOLOGY: AN OVERVIEW

Salvatore J. Grisaffe

ABSTRACT

The Materials Division at the Lewis Research Center has a long record of contributions to both materials and process technology as well as to the understanding of key high-temperature phenomena. This paper overviews the division staff, facilities, past history, recent progress, and future interests. The papers which follow expand on some of our research areas and plans.

LEWIS MATERIALS DIVISION

The Materials Division at the Lewis Research Center is NASA's focal point for high temperature materials research aimed at aerospace propulsion and power system needs. Lewis is NASA's largest materials research group. Currently the staff consists of about 99 civil servants (over 45 percent are Ph.D.'s) and 73 NRC post doctoral fellows, university consortia, support service contractors, and industrial guest investigators. Their backgrounds cover all the materials disciplines. Thirty percent of our staff represent recent graduates, reflecting an ongoing commitment to fresh ideas and new talent. Our facilities give us the capability to make, consolidate, and fabricate new materials and to test and analyze them. With the centers powerful computational capabilities, we can also model, compute, and predict material behavior.

Our job is to create new materials and new understanding in support of NASA's needs and specific materials goals. We then work to transfer the resulting knowledge, technology, and processes to the broad user community.

For those interested in collaboration on research of potential mutual interest, a description of our key facilities can be obtained by writing me a letter outlining your specific interests.

LEWIS MATERIALS DIVISION

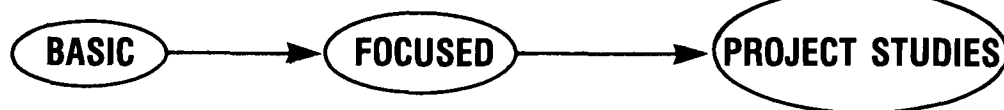
STAFF

- 99 CIVIL SERVANTS
 - 85 PROFESSIONAL
 - 45 PERCENT PhD
 - 32 PERCENT MS
- IN
 - CERAMICS/CERAMICS ENG.
 - CHEMISTRY/CHEM. ENG.
 - PHYSICS
 - METALLURGY/MET. ENG.
 - MECHANICAL ENG.
- 73 UNIVERSITY CONSORTIA,
NRC POST DOCTORAL FELLOWS,
SUPPORT CONTRACTORS, ETC.

FACILITIES

- LABORATORIES IN SEVEN BUILDINGS
- 40 M IN CAPITAL EQUIPMENT
- TO
 - CONSOLIDATE
 - FABRICATE
 - TEST
 - CHARACTERIZE
 - COMPUTE

MEET NASA'S MATERIALS NEED IN AEROSPACE PROPULSION AND POWER



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SOME MATERIALS DIVISION CONTRIBUTIONS

In the past Lewis has made many contributions to the technology of high temperature, high performance materials. In our laboratories, as well as in conjunction with industry, Lewis has pressed the advance of such concepts as:

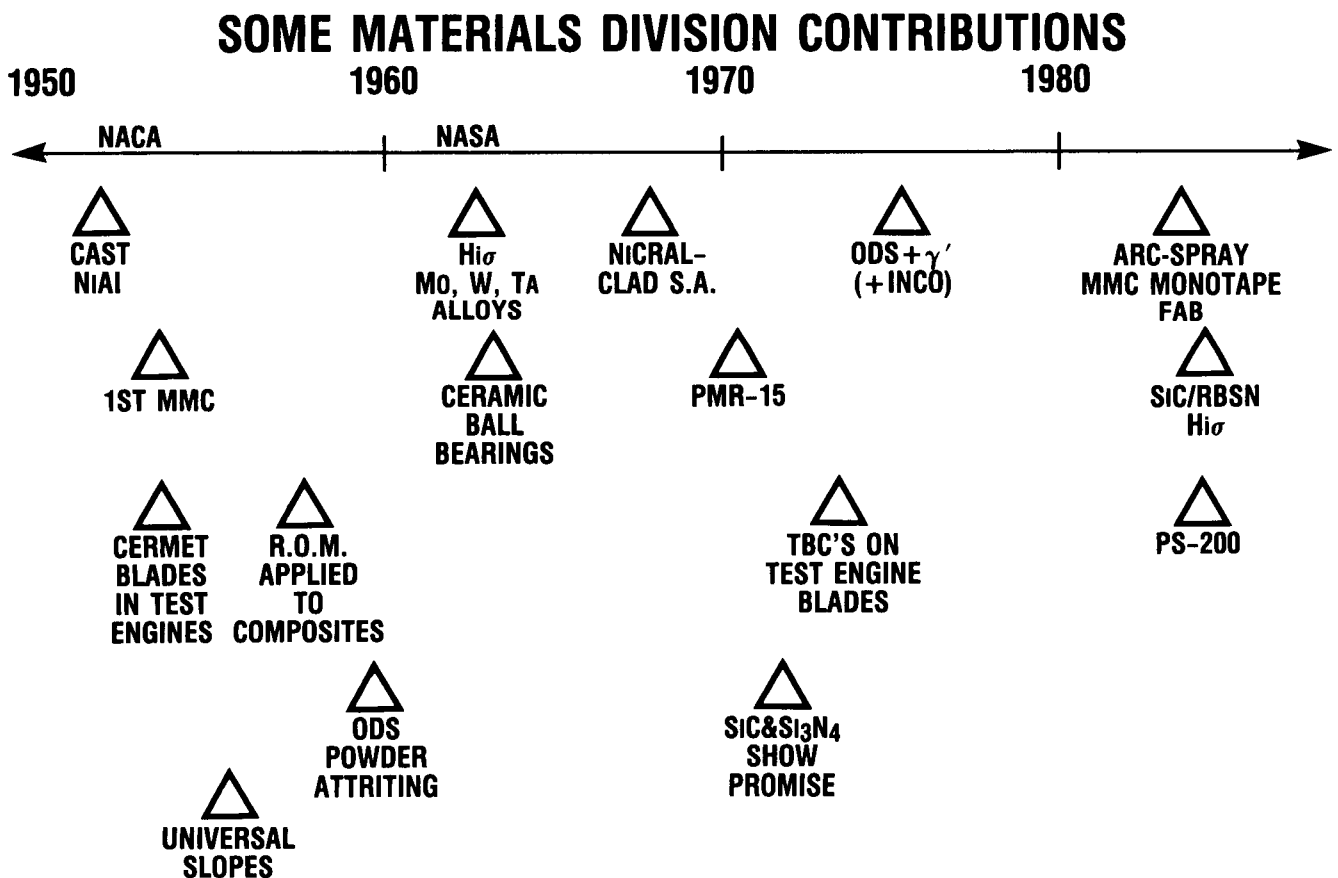
Metal matrix composites. - Continuous fiber reinforced metal composites were born at Lewis and the rule of mixtures was applied to property estimation.

Refractory metals and compounds. - New W or Mo+Re alloys were discovered at Lewis and then strengthened via Hf&C additions. We conducted much of the early work on HfC and TaC.

Ceramics. - Lewis conducted the first engine tests on brittle cermets, developed early blade root designs for brittle materials, identified ceramic ball bearing potential, and generated early data on Si_3N_4 and SiC ceramic potential for gas turbine service.

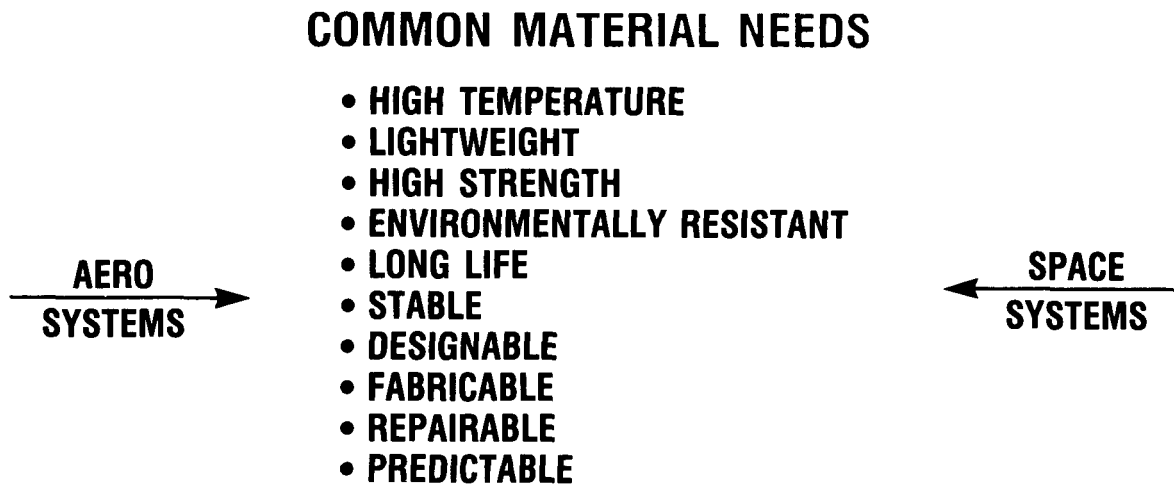
Coatings. - Lewis research resulted in early identification of NiCrAl and FeCrAl as surface protection systems for superalloys the first TBC's to work in oxidizing environments and to be tested on blades in engines.

Polymer composites. - PMR-15 was discovered at Lewis and we supported it through commercial introduction.



COMMON MATERIAL NEEDS

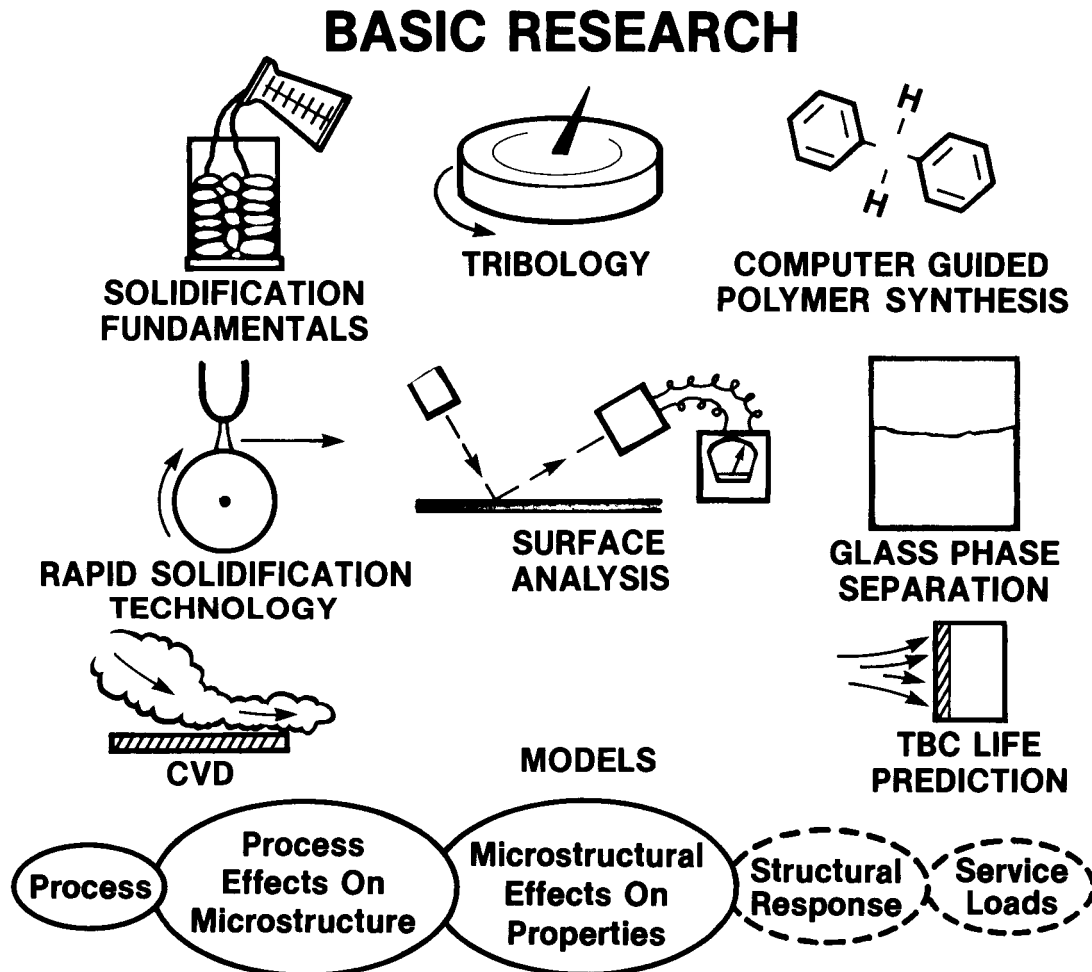
Today, propulsion system limits are limiting aircraft advances. Achievement of viable high thrust-to-weight aircraft, Mach 2 to 6 aircraft, very high efficiency/pressure ratio subsonic aircraft, VSTOL, NASP, etc. depend on advances in engine materials. Similarly, in the whole arena of space propulsion and space power, the availability of high performance materials is controlling advances. Many of the same needs exist for both types of systems. Indeed, as we move toward hypersonics, toward cryogenic fueled aircraft, and toward multiple reuse rockets, the temperature, performance, and life demands show significant overlap.



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BASIC RESEARCH

In response to such requirements the Materials Division is aiming its efforts toward advanced high temperature composites capable of meeting NASA and industry needs for the year 2000 and beyond. Our work involves basic research, focused research, and direct project support and consultation. About 20 percent of our work involves exploratory research and basic studies aimed at understanding key barrier phenomena. Some of these areas are shown. Note that as part of our efforts to mathematically characterize and predict material responses, we have a growing modeling activity supporting our experiments.



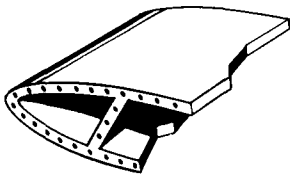
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FOCUSED RESEARCH AND TECHNOLOGY

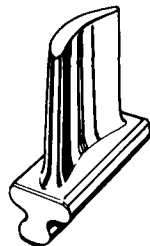
About 65 percent of our effort involves focused research -- looking at long range system needs and attacking those issues that would enable and enhance system performance. Such research covers a very broad range of NASA and industry interests. In the area of hypersonic engine structures (and advanced rocket nozzles) we are looking for high strength/high conductivity systems such as W fiber/copper composites for cooled applications as well as for high temperature ceramic composites for hard-to-cool components. Long life materials for high speed turbopump blades, bearings, etc. are being sought. Ceramic materials, intermetallic composites, and polymer conductors are all being pursued to provide lightweight high performance alternatives to current technology. In the high temperature superconductor arena we are supporting efforts aimed at NASA-specific applications. To enhance satellites and the space station's effectiveness we are working on improved lubricants as well as supporting the microgravity science and applications/commercial use of space programs. Here we do focused research on basic processing issues. Our microgravity materials science laboratory is a place where we work with industry and university investigators to help clarify their ideas and lay the ground work for potential space experiments or processing hardware.

FOCUSED RESEARCH AND TECHNOLOGY

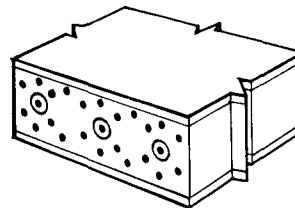
**HYPERSONIC
STRUCTURES**



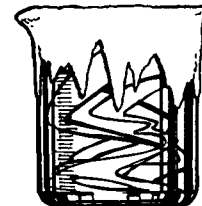
CERAMIC COMPONENTS



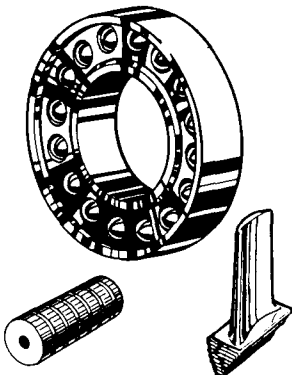
**HIGH T/W
CONCEPTS**



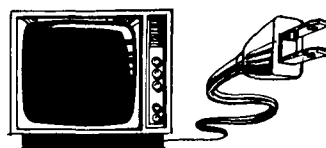
HTS



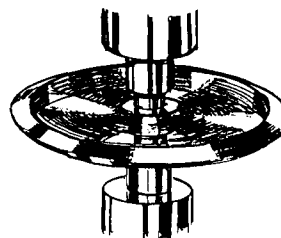
ADV. ROCKETS



**POLYMER
CONDUCTORS**



**SATELLITE
LUBRICANTS**



**MICROGRAVITY
SPACE PROCESSING**

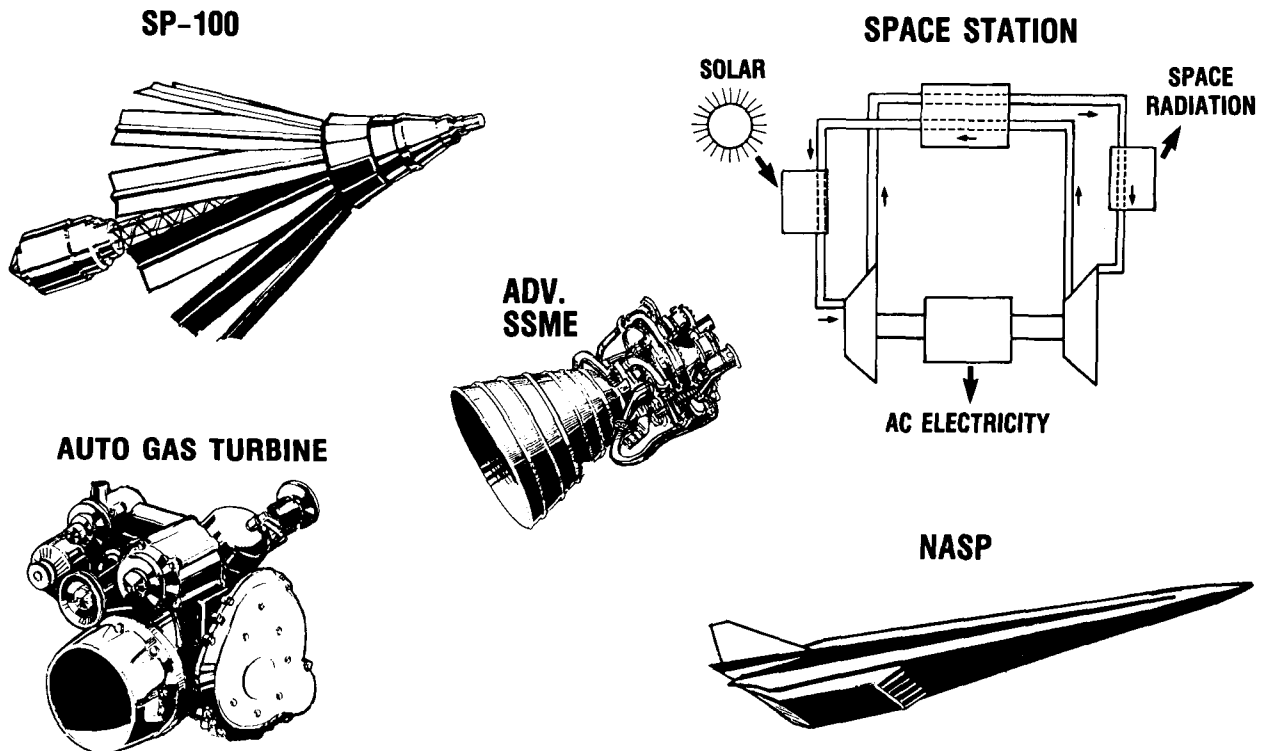


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SYSTEMS SUPPORT

About 15 percent of our effort supports systems where NASA has a major role in development. For example, our work on SP-100 includes materials for lightweight radiators, research that is clarifying the basis for Ge-Si/GaP thermoelectric performance improvements, and on high strength refractory composites for lithium-cooled heat pipes. Our support for Space Station includes identifying salts for thermal storage and corrosion resistant materials for their containment. In the auto gas turbine program that NASA manages for DOE, we have done a lot toward raising the reliability and reproducibility of monolithic ceramics and toward characterizing factors that currently limit their use.

SYSTEMS SUPPORT



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ORIGINAL PAGE IS
OF POOR QUALITY

ADVANCED HIGH TEMPERATURE MATERIALS FOR TURBINE ENGINES 1988 to 1993

NASA recognized the growing relationship between materials availability and system performance limits. So this year a new effort was started. It is called Advanced High Temperature Materials for Turbine Engines. This base R&T augmentation will concentrate on accelerating the exploratory and the focused types of work -- primarily aimed at readying high temperature composites for engine consideration. With this effort we will be moving to tie together both the materials development and the structural analysis efforts from the start in an attempt to reduce the 12 to 15 year time that new materials normally take to reach system use. We are also trying to create new linkages between ourselves, industry, and the universities. This coordination will benefit U.S. aeropropulsion by concentrating the diversity of views and backgrounds on moving such revolutionary materials forward. Specifically, we expect future advances in:

Fibers. - Improved fiber properties and temperature limits, fiber coating to control interface reactions, and interface characterization methods.

Composite fabrication. - Optimizing current processes, but looking for better ways so as to create options to make complex shapes economically in a reliable manner.

Testing and analysis. - New methods and facilities to generate high temperature property data and to verify the new analytical codes and models to guide lay-up and fabrication.

Life and failure analysis. - Better ways to relate multiphase microstructures to properties and eventually properties to component performance.

Ideas. - New ideas to help create a "next generation" basic industry capable of a strong role in world trade.

ADVANCE HIGH TEMPERATURE MATERIALS FOR TURBINE ENGINES 1988 TO 1993

EXPECT FUTURE ADVANCES IN:

- CERAMICS
- INTERMETALLICS
- REFRACTORY METALS
- POLYMERS

FIBERS AND
COMPOSITES

